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Before the
**FEDERAL COMMUNICATIONS COMMISSION**
Washington, DC 20554

In the Matter of

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| Admendment of the Commission's Rules to Establish a Single AM Radio Stereophonic Transmitting Equipment Standard | } | ET Docket No. 92-298 |

# REPLY COMMENTS OF MOTOROLA INC.

Respectfully submitted by:

Michael D. Kennedy
Director, Regulatory Relations

Michael A. Menius
Manager, Common Carrier Relations

Motorola Inc.
Government Relations Office
1350 I Street, N.W., Suite 400
Washington, DC 20005
(202) 371-6900

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## EXECUTIVE SUMMARY

Motorola strongly supports the proposal to adopt the C-QUAM system as the United States standard for stereophonic AM broadcast radio service. The lack of an official U.S. broadcast standard for AM stereo has apparently retarded the availability of AM stereo non-auto receivers in this country. Adoption of the C-QUAM standard will benefit AM service listeners by encouraging the availability of more AM stereo receivers and transmitting facilities, thereby providing the American public with higher quality AM broadcasts.

The Commission's proposed action is fully consistent with the expressed legislative intent to advance AM stereo service. The Congressional directive was unambiguous, to select an AM stereo broadcasting standard, and C-QUAM is clearly the appropriate choice. Despite technical and business environment objections raised at the comment stage by some competitive interests, C-QUAM is a robust technology which has stood the test of time, both in terms of marketplace acceptance and laboratory tests of system performance. Certainly, no additional tests are needed or appropriate at this point, whether by the government or industry entities (which would simply add to the enormous body of tests already performed. These tests consistently confirm the superior characteristics of the C-QUAM system). Finally, there are no legal impediments to the Commission's proposed action. As discussed below, outstanding allegations by one competitor are currently being pursued in appropriate legal fora. These issues are outside the scope of the instant rulemaking. Moreover, these issues are outside the purview of this Commission's regulatory oversight.

The standard selection should not be delayed or modified on the basis of any technical issues raised in the comments. These discussions concern the comparative merits of various AM stereo systems and are addressed below. These questions, however, are not new. On the contrary, they

have all been extensively examined through the years and are thoroughly documented in previously filed documents. The technical criticisms have already been thoroughly refuted through Motorola's participation in all system trials conducted throughout the world for AM stereo. Finally, if there were any validity to these often repeated assertions, C-QUAM could not have achieved such widespread acceptance among those broadcasters which have elected to invest in AM stereo systems.



## DISCUSSION

The comments provide ample support for the Commission's proposal to adopt C-QUAM as the U.S. standard for AM stereo broadcasts. See, for example, the comments of the National Association of Broadcasters (NAB), EIA's Consumer Electronics Group, Harris Corporation-Harris Allied Broadcast Division, Delta Electronics, and Broadcast Electronics, Inc. The adoption of the C-QUAM standard is plainly in tune with the sentiment of the AM broadcasting industry, which is in the best position to assess and comment on the sentiment of the AM marketplace.

As the inventor and developer of the C-QUAM system, Motorola has been a major proponent, participant in and contributor to AM stereo since the mid-seventies. Through the years, C-QUAM has become the medium wave stereophonic broadcasting system of choice in those countries of the world that have adopted a standard. It has also been widely recognized as the *de-facto* standard of the United States.

C-QUAM could not have gained its dominant world position without its robust performance merits. Presently, C-QUAM is being utilized on over one hundred different models of transmitters, is employed at nearly one thousand transmitting stations worldwide, some 700 of

which are in the U.S.[1] Also, approximately twenty-five to thirty million receivers incorporate C-QUAM AM stereo. C-QUAM is a proven system that has stood the test of time for over 10 years.

## I. THE FCC'S PROPOSED ACTION IS APPROPRIATE AND IS IN THE PUBLIC INTEREST.

### A. The Proposed Action is Fully Consistent with the Congressional Directive and the Underlying Legislative History.

In initiating a rulemaking to adopt an AM stereo broadcasting standard, the FCC acted completely within its legislative directive:

> "the Federal Communications Commission shall . . . [W]ithin 60 days after the date of enactment of this Act, ... initiate a rulemaking to adopt a single AM radio stereophonic transmitting equipment standard. . ."[2]

In its comments, Hazeltine erroneously contends that the Commission, in proposing C-QUAM as the AM Stereo standard, somehow acted inconsistently with its legislative directive. According to the Hazeltine interpretation, Congress's intent was to stimulate a sagging AM radio market, but whether or not AM stereo service is advanced is only a "vehicle" chosen by Congress.[3] This argument overlooks the specific legislative language which not only addresses AM stereo but also requires a standard to be adopted. The legislative history of S. 1101, the bill that added Section 214 - - the AM Improvement Standard - - to the Telecommunications Authorization Act of 1992, ("The Act"), underscores this point:

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1 The estimated U. S. number includes about thirty Harris C-QUAM compatible signal systems and also about thirty-six that are "in process."

2 See Telecommunications Authorization Act of 1992, Pub. L. No. 102-538.

3 See Hazeltine comments, at 9 - 10.

"This legislation requires the Federal Communications Commission FCC to adopt a single standard for AM radio stereophonic transmitting equipment by specifying the composition of the AM stereophonic signal.

"The Committee finds that stimulation of the AM radio market is dependent upon the establishment of an AM stereo standard... the Committee recommends that the FCC be required to establish such a standard. [emphasis supplied][4]

Even if the legislative interpretation proffered by Hazeltine were correct (which it is not), the choice of C-QUAM is fully consistent with the Commission's asserted rationale in selecting the C-QUAM system. It is clear that Congress intended to advance AM stereo service. The Report states that "[t]he objective of S. 1101 is to provide a viable marketplace for investors in AM stereo broadcasting."[5] The import of this language is plain: Congress intended, as the FCC has recognized,[6] to encourage existing and future investment in AM stereo service through the adoption of a single AM transmission standard. The remarks of Senator Pressler bear this out. In introducing the legislation, Senator Pressler mentioned two reasons for the bill, both of which indicate a specific intent to advance AM stereo service:

1) "[T]he quality of AM reception in the far reaches of my state is low. The thousands of farmers and ranches in rural South Dakota, many of whom are without FM stereo, want to receive better quality sound. AM stereo technology offers a good solution because it can broadcast greater distances than FM stereo."[7]

2) "One needs only to look at Japan to understand how much this legislation is needed here. Two weeks ago the Post Ministry of

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[4] S. Rep. No. 451, 102d Cong., 2d Sess. (1992).

[5] Id. at 1.

[6] Amendment of the Commission's Rules to Establish a Single AM Radio Stereophonic Transmitting Equipment Standard, ET Docket No. 92-928 (released Jan. 6, 1993) at par. 6: "existing AM broadcasters would forfeit their investments in C-QUAM transmission equipment."

[7] 137 Cong. Rec. S6149 (daily ed. May 21, 1991) (statement of Senator Pressler).

> Japan decided to abandon its policy of allowing the marketplace to settle on one system and adopt a single AM broadcast system - Motorola's C-QUAM stereo throughout Japan. America needs to act now to avoid falling further behind in the development of AM stereo."[8]

Moreover, even if Hazeltine's contention were accurate, which it is not, the FCC's asserted justification for its selection of C-QUAM applies with equal force. If Congress intended only to stimulate the economic health of AM broadcasters, then the FCC has effectuated Congressional intent by selecting C-QUAM because, as both Congress and the FCC have found, broadcasters, manufacturers and consumers have already invested substantial sums in this technology.[9] Indeed, the Regulatory Impact Statement that accompanied the Report of the Senate Committee on Commerce, Science, and Transportation on S. 1101 noted:

> This bill, as reported, imposes a limited burden on some equipment manufacturers and broadcasters. As a result of this legislation, those manufacturers whose equipment is incompatible with the standard set forth by the FCC may have to retrofit manufacturing plants.

In addition, broadcasters whose transmitting equipment is not compatible with the FCC standard

[redacted]

Thus, the Congress recognized that the Commission in the short period allotted by Congress for the rulemaking, could very likely conclude that C-QUAM would best serve the public interest as the AM stereo standard.

Commission rejection of the de facto standard would, at the very least, impose significant additional costs on all parties and undermine the faith of the investment community in AM radio. These considerations were already extensively covered in the legislative history. Indeed, absent an extraordinary record to the contrary, it would be difficult to square a decision to adopt a standard other than C-QUAM with the legislation that mandated adoption of a single standard.

B. No FCC Investigation Is Appropriate of Any Ongoing Allegations Which Are Currently, and Properly, Being Pursued Through Judicial Tribunals. These Issues Are Not Appropriate For Deliberation In The Instant Proceeding And Are No Impediment To Selection Of An AM Stereo Standard.

In comments filed by Mr. Leonard R. Kahn ("Kahn"), there is a confidential appendix submitted, in which the following statement appears:

> "Adoption of the Motorola AM Stereo System would (a) violate the Federal Communications Act 47 U.S.C. Section 313 as amended, and (b) aid and abet

factual or legal basis and have been raised at this time only with a view to delaying Commission action.[11]

Kahn's argument that adoption of C-QUAM would violate 47 U.S.C. Section 313 is completely misplaced, since Section 313 simply provides that a finding that a person has violated the antitrust laws is grounds for revocation of the FCC licenses held by that person and is not applicable to the present docket which examines the selection of a broadcasting standard, not actions by licensees.

Motorola further submits that an inquiry into these allegations by the Commission as requested by Mr. Kahn is both inappropriate and unnecessary. The United States District Court, before which

the same conclusion as the aggregate of tests of the last 15 years by the NAMSRC, Delco, Japan, Canada, receiver manufacturers, individual broadcasters, and the nearly 700 broadcast stations on the air in the U.S. ISB declined to participate in the formal tests of the NAMSRC and Delco. Kahn was repeatedly invited to participate but did not. It was only when he was forced to test (or not be considered) by foreign governments such as Japan, that Kahn allowed ISB to participate. In all comparative tests, the Motorola C-QUAM performance was equal to or better than the ISB system. Even the recent in-depth Japanese tests[12] proved that the C-QUAM system was robust and provided excellent stereo service. Although the Japanese public summaries of the test results indicated that the systems performed similarly, detailed examination of the data shows that the C-QUAM performance was superior to ISB in most respects.[13] In summary, the length and breadth and results of all of the tests of the past 15 years show there is no need to repeat confirming data.

Hazeltine suggests that, since receivers are not available for the (Kahn-Hazeltine) ISB system,

choose the C-QUAM system when only limited numbers of auto sets were available for the C-QUAM system while ISB-optimized sets were available in portable, auto, and table top type radios. The Sony AM Stereo radios were eventually withdrawn from the market due to disappointing sales results.[15] At about the same time, the number of C-QUAM stations on the air began to exceed the number of ISB stations on the air and subsequent growth continued to the present.

During these early years of the marketplace non-standard, numbers of broadcasters who were using the ISB system tried and were more than satisfied with the Motorola C-QUAM system. In most cases, performance after C-QUAM conversion was better than it had been with ISB. Some broadcasters who converted from ISB to C-QUAM became the best supporters for C-QUAM because of their comparative experience. The ISB system had the leadership position in AM Stereo during the period of time that it was the only system available. As soon as other proponents began to supply broadcast equipment, the ISB position began to slip and never recovered. The historical fact is that, as soon as the broadcasters had choices of Harris and C-QUAM equipments, ISB started its downward slide which has continued to the present.

Hazeltine reasons that C-QUAM has been rejected by 88% of the broadcasters who have not converted to AM Stereo. This is nonsense. The same reasoning would conclude that ISB, in spite of its early-on leadership position, has been rejected by over 99% of the broadcasting community.[16]

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[15] Sony indicated that it ceased manufacture of multi-system radios for marketing reasons.

3 Hazeltine's attempt to rewrite history is not only incorrect, it is disingenuous. For an objective review of the history of AM Stereo, interested observers are encourage to read "Technical Standards and the Marketplace: The Case of AM Stereo" by Bruce C. Clopfenstein and David Sedman — Journal of Broadcasting & Electronic Media, Volume 34, No. 2, Spring 1990, pps. 171-194.

Over 95% of those U.S. broadcasters who have converted to AM Stereo have chosen C-QUAM. In addition, Motorola surveys of 1988 and 1991 both showed that over 80% of the U.S. broadcasters recognized C-QUAM as the de facto standard. Those broadcasters who have not embraced AM Stereo have indicated primary reasons of cost, lack of a variety of AM Stereo radios, and lack of a standard. NAB testimony has most certainly underscored the extreme cost sensitivities of most AM broadcasters.

Acceptance of C-QUAM continues to grow in the broadcast industry. Equipment manufacturers such as Delta are now marketing low cost broadcast exciters, and others, such as Broadcast Electronics are marketing new, high efficiency transmitters that have C-QUAM stereo circuitry built in. Nautel and Harris have also introduced transmitters with C-QUAM exciters built in. In response, C-QUAM licensees have noted a marked upward trend in the sales of AM Stereo related equipment.[17]

Lack of receivers other than automobile types has been survey cited as a conversion deterrent to broadcasters. However, the setting of a standard will encourage receiver manufacturers and is therefore in the public interest. U.S. auto radio manufacturers have embraced AM Stereo and offer it in many car models. Foreign manufacturers of OEM auto receivers have also followed suit because of the need to compete with U.S. manufacturers. On the other hand, the portable, table top, home stereo, and boom box markets are dominated by foreign interests. While many of them now have C-QUAM designs in production for sale in Japan, these designs have not yet entered the U.S. market.

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[17] It is also interesting to note that most of the C-QUAM systems sold are still on the air. ISB cannot

The setting of a stereo standard in the United Stated directly addresses two of the concerns receiver manufacturers have offered for non-participation, viz., lack of a standard and lack of consumer demand. A standard will remove risk and encourage receiver manufacturers, particularly Japan, to export more AM Stereo receivers. This should result in more consumer awareness and demand. The setting of a U.S. standard is in the public interest.

Receiver manufacturers have had the opportunity of choice. The so-called multi-system receivers of all types, including automobile, portable, and table top versions were introduced and available to the marketplace. All proponents had equal opportunity to sell the merits of their respective systems to receiver manufacturers. Furthermore, the Sony multi-system chip set was available for purchase by receiver manufacturers. Very few chose to test market sets using the Sony chip set due to cost, complexity, and performance. National Semiconductor, Sprague Semiconductor, Signetics, and Sanyo were also active AM Stereo participants and stood ready to manufacture IC decoders for any system that receiver manufacturers were ready to purchase in quantities.[18] In fact, these companies made major investments in developing AM Stereo decoder techniques and/or chips. Even Hazeltine designed and repeatedly promised an economic multi-system chip to the industry via Ed Onders. Apparently, Hazeltine either found no takers for its multi-system decoder design or discovered it was not cost and/or performance effective. The fact is that multi-system concepts had more than ample opportunity to prove their merit.

Kahn also claimed to show the receiver industry how to inexpensively utilize a C-QUAM decoder and modify it to receive ISB. A true review of history shows that had any real demand for ISB receiver decoder circuits developed, IC decoders for that system would have become available. The receiver and the integrated circuit manufacturers did indeed have many choices. Hazeltine

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[18] It is reasonable to presume that any and all consumer IC manufacturers would not have turned down large orders for decoders of any type.

poses a scenario starting point that, after the receiver manufacturers made their choices, they had no choice. This is convoluted logic.

Hazeltine suggests that a simple, cost effective method exists to convert the tens of millions of C-QUAM radios to the ISB system. The circuitry referred to is the Kahn so-called "SECRET" adapter which contains additional components to decode the ISB signal when attached to a C-QUAM decoder. It is irrational to think that the public will bring back their automobile to have an adapter unit fitted to the receiver. Many auto receivers do not even have ample space to contain the additional circuitry. The radio would need to be removed from the dashboard of the car, modified, which includes addition of up to a dozen external connections to the printed circuit board of the receiver, and re-installed into the car. Such a process would most likely not only void the warranty of the radio, but also cannot possible be construed as either simple or low cost. The "SECRET' has also had its opportunity of choice and the marketplace properly buried it.

Hazeltine suggests that it is not a financial burden for stations to discontinue use of C-QUAM broadcast equipment. In view of the NAB testimony regarding the losing financial status of many AM stations, and in view of reported Motorola surveys showing cost is a major broadcaster concern, Motorola is surprised by the Hazeltine position. Hazeltine claims that the greatest cost is in the studio and STL equipment. It is true that conversion of the entire studio from monaural to stereo is expensive if done from scratch. However, most stations already have stereo boards and stereo playback equipment. In addition, most satellite music formats are delivered in stereo. Therefore, even a monaural station must receive both stereo channels and sum them together to produce a monaural on-air broadcast. Stations using a monaural STL can upgrade to stereo by adding a second STL channel. Equipment is available to do this at approximately $6000 to $7500.

The approximate $12,000 cost of the stereo exciter and monitor is expensive to many broadcasters. Furthermore, this equipment, if removed due to a choice of stereo standard other than C-QUAM, would instantly lose most of its value. The broadcaster would then need to purchase new equipment (at an expense of between $15,000 and $20,000 if it is Kahn ISB equipment). In addition, many stations would also need to factor in the additional cost of installation by a qualified consultant. The total cost could readily approximate $30,000 to $40,000 for obsolete and replacement equipment. This is a very expensive penalty for many broadcasters. But the ratio of broadcasters in the U.S. using C-QUAM vs Kahn is approximately 35:1. Hence, the Hazeltine position that it would not be costly to switch to ISB is curious.

Hazeltine implies that C-QUAM, in some way, may have reduced the economic viability of stations through technical performance. These allegations are untrue. Because these allegations have been raised in the past, it has been common for broadcasters, upon conversion to C-QUAM, to immediately check coverage and on-air signal quality. This was especially true of the stations that converted from the ISB system to C-QUAM. Had any broadcaster experienced a loss of coverage or a degradation in the quality of his/her on-air product, C-QUAM momentum would have ceased immediately.

Some of the comments (Kahn and others) raised questions concerning the validity of the statistics furnished by Motorola concerning marketplace penetration of C-QUAM. These statistics are in fact quite reliable and routinely updated. The C-QUAM station "on-air" list that is maintained by Motorola is frequently updated to not only include new stations, but also to remove those stations which have, for whatever reason, removed the stereo equipment from use.[19] Kahn improperly

[19] Please note that it is next to impossible to be perfectly correct for 700 U.S. and 300 foreign stations when so many changes occur in a given year. Motorola invites list recipients to phone in known errors so that they can be corrected.

infers that 87.8% of the U.S. AM stations have rejected C-QUAM . This is an improper conclusion.[20] Consider the statistics:

- Over 95% of the U.S. broadcasters who have chosen to operate in stereo have chosen C-QUAM .
- In Motorola Broadcaster Surveys[21] of 1988 and 1991, over 80% of the respondents to the question indicated acceptance of C-QUAM as the U.S. *de facto* standard.
- Based on the '88 Motorola Broadcaster Survey Questionnaire, specific reasons for non-conversion were solicited and the major reasons offered by the respondents to the question, in order of importance were:

  - Financial
  - Receiver Availability
  - No Standard
  - Other

- Some 700 U.S. stations now broadcast in C-QUAM stereo.

Obviously the broadcasters have been making their C-QUAM choice known. Furthermore, the NPRM is impacting on two of the above impediments to faster growth, viz. availability of receivers and lack of a standard. Kahn's criticisms of C-QUAM's broadcaster acceptance and of Motorola's statistics are unfounded.

Motorola comments regarding the "on-air" statistics of other systems, including ISB systems, are accurate and are based on phone surveys. Of course, the surveys do not consider Kahn Power

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[20] It is interesting to note that, based on the same type of improper logic, over 99% of the U.S. AM broadcasters have rejected Kahn's ISB system.

[21] Approximately 4500-4900 mailings, each survey; 1991- 457 respondents; 1988 - 558 respondents.

Side stations, stereo pilot tone or not, as stereo because they do not transmit stereo (i.e., two channel program content).[22]

The Commission has an accepted procedure for type accepting AM Stereo broadcast equipment. Present rules include tone tests up to 7.5 kHz and program material tests.[23] In addition, the rules require each station to be accountable for its own emission verifications. Acting upon a complaint filed by Kahn in 1986, occupied bandwidth measurements were performed on dozens of AM Stereo stations by the FCC.[24] Motorola also performed field tests of both C-QUAM systems and ISB systems. Two of the FCC tested stations showed fleeting instances of out of band emission. Neither station was C-QUAM. In fact, both were using the ISB system. All C-QUAM systems tested were in full compliance.[25] Motorola's own field tests indicated similar results. Kahn was wrong in 1986 and is wrong again now with criticisms of C-QUAM occupied bandwidth.

CTI questions the reasons why stations have not converted, when the stations converted, what the current rates of conversion are, and if stations that have purchased equipment are still on the air.

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[22] The legality of the Power Side broadcasts might be questioned. Terming such transmissions as "stereo" may skirt the issue, but international agreements with Mexico and Canada note that MW broadcasts consist of either: A) a double sideband, full carrier monophonic transmission, or B) stereophonic (i.e., two channel stereo) transmission of a type accepted format. The Power Side system transmits most of the signal in one sideband.

[23] Earlier rules require tones up to 5 kHz and allowed a waiver to the Kahn system in the then-required distortion and separation measurements.

[24] The 1986 tests cited above were prior to the recent NRSC RF emission mask program. After the pre-emphasis and audio bandwidth limitations were finalized by the NRSC committee, Motorola proposed an RF mask which formed the starting basis for the current rules. It is interesting to note that the emissions mask proposed by Motorola was more stringent than that ultimately adopted by the NRSC committee. In test after test, domestically and abroad, C-QUAM has shown that it is spectrally efficient. Kahn alleges that the rules have been eased to allow stereo. But the fact is that the rules have been dramatically tightened through the incorporation of the NRSC-3 emissions mask.

[25] In all fairness, the Commission referred to the ATS rules that allow up to 10 over modulation peaks per minute, which would account for the ISB out of band emissions.

Motorola has repeatedly provided the answers to these questions. Motorola has periodically reported timely survey results on the status of AM Stereo and also on identification of impediments to rapid growth. In addition, Motorola has audited "on-air" stations and has invited all interested parties to help Motorola keep its C-QUAM station list accurate. With nearly 700 U.S. and 300 foreign stations to try and track, and with the AM turnover statistics of today, the task has been formidable. Motorola has shared the results of its surveys through its AM Stereo News Bulletins and through participation in various related FCC Proceedings. Those surveys show that the major reasons offered for non-conversion are cost, not enough receivers available, and lack of a standard. NAB surveys have verified the broadcasters extreme sensitivity to cost. As Motorola has testified to the Commission, the lack of receivers is related to the lack of a standard. Manufacturers, especially the foreign companies who control non-auto radios, are reluctant to build receivers when no established government standard exists.[26] The FCC NPRM should alleviate these impediments.

Broadcaster conversions peaked in the mid-1980's as automobile receiver manufacturers introduced large numbers of AM Stereo radios to the marketplace. A significant dip occurred when the FCC "freeze" was enacted due to uncertainty about the new rules. Last year, when the FCC announced that AM Stereo would be standardized within one year, conversions began increasing

[26] Motorola has also frequently reported its findings relating the major reasons receiver manufacturers have not participated in AM Stereo, viz. cost, lack of consumer demand and lack of a standard.

again.[27] Most recently, the introduction of new transmitters with C-QUAM Stereo "built in" has given additional impetus to the growth rate.[28]

Motorola estimates of stereo receivers are based on IC units shipped, allowing for normal time delay for receiver manufacturing. Although the estimates have been world wide, the majority of the receiving sets have been shipped to the United States.[29] Our Comments conservatively reflect the facts as best as can be tracked. Any receiver estimate errors are most likely on the low side because C-QUAM decoders produced by other companies are not readily tracked by Motorola and are rapidly increasing in quantity due to Japan's adoption of the C-QUAM standard. At this point in time, there are no better or accurate receiver statistics available than those provided by Motorola.

The interest in C-QUAM by other receiver manufacturers is global in scope. The receiver manufacturers who have licensed C-QUAM include: Aiwa, Alpine, Ashai, Beltek, Benytone, Clarion, Fujitsu, Funai, Goldstar, Hitachi, JVC, Kahomusen, Kenwood, Konic Corporation, Kyocerak NEC, Maruwa, Matsushita, Mitsubishi, Nakamichi, Nippon Columbia Co., Ltd., Onkyo, Pioneer Electronics, Sansui, Sanyo, Sekisui Chemical, Sharp, Shintom, Sony, Technol Ace, TKR, Yamaha, Vectron Technology, Inc., Taiwan, Sangean Electronics, Becker, Star Micronics, Potomac, Toshiba, Toko, General Motors - Delco Division, Ford Motor Company, and Chrysler Corporation.

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[27] Motorola has been diligent in efforts to produce an accurate "on-air" list. While there are obvious reasons for some errors, it is believed that the actual "on-air" total is always larger than our report total. This is because there is a time lag in including new stations, particularly those recently put on the air by C-QUAM licensees.

[28] New AM Stereo transmitters have been introduced or announced by Broadcast Electronics, Nautel and Harris Broadcasting.

[29] In the past 12 months, Motorola estimates that 2 to 4 million of the radios have been consumed in Japan. It is difficult to be more accurate in this figure because there are several IC manufacturers supplying the Japan market.

Foreign receiver manufacturers have been slow to enter the non-auto radio markets in the United States. Motorola queries have indicated that the primary reasons for this are cost, lack of consumer demand, and the lack of a standard in the United States. But there is good reason to expect this to change. For example, the day that Japan initiated C-QUAM broadcasting, the market place was simultaneously provided with receivers of all types. Even now, one year after the inauguration of stereo broadcasting in Japan, manufacturers are still struggling to meet the demands of the Japan marketplace. There is every reason to believe that adoption of a single standard in the United States will encourage foreign manufacturers to produce AM Stereo products of all types for the

conclusions indicated that the systems performed about the same and that multi-system receivers were possible. Upon further study and more experience, however, the NTIA concluded that multi-system receivers would cost substantially more than single system sets and that the price constraints and receiver manufacturer resistance would not support this design direction.

The C-QUAM system has been under comparative evaluation since the mid-seventies. It has proven its merit over and over as the other proposed systems, including ISB, have failed to gain significant marketplace acceptance. Most all of the 1000 C-QUAM systems sold are still on the air.[30] ISB cannot make the same claim. Kahn claims that roughly 200 ISB systems have been sold. But Motorola polls of claimed Kahn stations indicate that less than 20 are in "on-air" use in stereo. This means that over 90% of the stations that have tried the ISB system have rejected it, for whatever reason. There are no bases for either choosing the Kahn system or claiming the need for additional comparative tests.

One C-QUAM critic suggested the use of a single sideband stereo system which put all the information on one side of the carrier. The engineering of such a system is unclear at the very least. Such a system would apparently either require 4 kHz bandwidth for each channel and perfect audio filters to extract the information (it would also be incompatible with existing monaural receivers). A linear single sideband signal has equal in-phase (I) and quadrature (Q) components. All compatible AM Stereo systems place the sum channel information in the envelope domain, while linear systems would place this in the I domain. The stereo difference information is transmitted in the phase domain or, in the case of a linear system, in the quadrature domain. If a single sideband signal is generated, the I and Q, or the Envelope and Phase channels, are fully occupied when driven from one channel of information. The other channel must therefore occupy

[30] Some have been repurchased and returned to air at a different station — perhaps more than once. This is not a rejection of C-QUAM but a reflection of the financial state of AM radio.

a totally different part of the bandwidth if it is to be separable. The proposal of occupying one sideband for both channels without a severe reduction of audio response does not appear to be feasible.

The question was also raised in the comments, of 9 kHz channel spacing for the U.S. This issue was previously raised, and rejected, in the lat 1970s. The NPRM did not re-open the question in the instant rulemaking to select a standard. The channel spacing issue should not be addressed.

SUMMARY STATEMENT

None of the criticisms or proposals of the Group of Commenters has presented convincing arguments.

Linear ISB as an alternative stereo system is not feasible. The Hershberger comments suggest that linear ISB is a superior system to C-QUAM. But there are major problems with this technology that cannot be glossed over. The first, and perhaps the most important problem, is that of envelope compatibility. Switching to a linear ISB system is incompatible with the existing hundreds of millions of envelope detector radios. This problem alone is sufficient justification against the choice of linear ISB. There are also additional technical objections to either linear ISB or Linear QUAM that show they are not viable alternatives to
C-QUAM.

The only difference between linear ISB and Linear QUAM is the addition of 90° all pass phase shift networks to linear ISB. The technical problems of implementing either are complex and extremely difficult to correct, given the range of modern and older transmitters in use today. The first of these is amplification and transmission of the signal. While a low level ISB signal can be amplified

in a linear fashion, this results in very inefficient power consumption and has severe compatibility problems with existing transmitters. It is simply not practical to remove all broadcast transmitters from service and replace them with linear amplifiers. Hence, envelope restoration techniques are utilized. But these linear systems produce low frequency poly-syllabic and transient DC terms into the audio modulator chain. DC terms simply cannot be accommodated. Low frequency audio terms, at the poly-syllabic rate (7-15 Hz) tax the modulator of newer transmitters and actually over burdens older, high level modulated transmitters.[31] The modulator must also pass all relevant harmonics of the highest modulating frequency in exactly the right phase if spectral cancellation is to occur. For an audio bandwidth of 10 kHz, the modulator should be amplitude and phase flat to the harmonic sidebands in order to cancel the corresponding phase modulation harmonic sidebands at the transmitter output. Not only is this difficult, it is virtually impossible on newer, high efficiency PDM transmitters which use 70 kHz as a switching frequency. It is already difficult to design an efficient (low loss) baseband filter that also simply rejects switching components and audio sidebands centered at 70 kHz. In fact, sidebands centered about 70 kHz alias the baseband and cause an increase in occupied bandwidth even if the filter were realizable. DSP technology does not simplify the filter or its complexity because PDM transmitters utilize series filters which must carry the sum of all current to the PA stage of the transmitter as well as standoff the voltage applied to the power amplifier tube. It is very likely that, on many transmitters, the phase mismatch between the phase modulated carrier sidebands and the complex amplitude modulation sidebands would result in spectra characteristics that are of far greater magnitude than that of C-QUAM. The argument favor of linear ISB glosses over these very real world problems which prevent implementation of ideal linear stereo systems.

Audio processing of ISB signals is also difficult and inefficient. SSB type signals are commonly

volume radios must continue to use analog phase shift networks. In the volume receiver industry, costs measured in pennies are very significant. The additional cost of the required capacitors, resistors, extra pins on the IC, and extra silicon are additional impediments to quantities AM Stereo receivers. Receiver manufacturers have cited cost as a major impediment to faster growth for AM Stereo radios.

## IV. TECHNICAL ISSUES RAISED IN THE COMMENTS INCORRECTLY DESCRIBE C-QUAM'S PARAMETERS. THE OBJECTIONS RAISED DO NOT POSE VALID IMPEDIMENTS TO ADOPTING THE C-QUAM STANDARD.

In its comments, CTI discusses the question of whether there are "platform motion" problems which occur in C-QUAM under reception conditions of high interference. From a real-world standpoint, it is evident that so such problem exist. C-QUAM's acceptance as a standard by Australia, Canada, Mexico, Japan, Brazil, South Africa, its use by over 1000 broadcasters and in 25 - 30 Million C-QUAM receivers are testimonials to the fact that this is a non-issue. In fact, if C-QUAM had any significant performance problems, it would have been abandoned long ago.

Through the years, the "platform motion" issue has repeatedly been raised. Motorola has consistently pointed out that any deleterious "platform" effects occur well below the 20 to 26 dB interference levels at which listeners change stations.[32] Furthermore, these effects are intelligently blended in Motorola designed decoders.

DAB compatibility would be an inappropriate requirement and is outside the scope of this proceeding. In its NPRM the Commission stated, "The [Congressional] Authorization Act is clearly intended to address an AM Stereo standard within the context of the current analog

[32] It should be apparent to all that the receiver manufacturers agree with Motorola's position.